** An On-Farm Protocol to evaluate the effect of Napier and Crop based rations on milk production in Babati district, Tanzania**

Authors

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1. **Background**

Africa RISING through the Integrated Livestock Feed component (ILF) component is working towards improving utilization of locally available livestock feeds (crop residues and grains) and introduction of forages in the maize-based systems of Babati district as a land management strategy. To achieve this goal, Improved forages such as Napier and Brachiaria grass and fodder legumes (e.g Desmodium) have been integrated into the system. The current small-holder production systems revealed a lot of wastage of the improved forages and crop residues due to poor processing, storage and feeding. The situation analysis in the district also showed that all farmers in the study area rarely supplement their cattle and feed animals with unbalanced feeds comprised of either maize bran, sorghum or sunflower seed cake resulting to low milk yield and nutritional diseases.

Feed conservation, handling, transportation, feeding and utilization of locally available feeds is amongst challenges limiting growth and improvement of small scale dairy production. These challenges can be solved or minimized by introducing improved livestock feed processing technologies like forage chopper and grain miller and Mixers to the small scale, crop livestock farming system groups in six Africa RISING villages of Babati district. The forage choppers and grinders will enhance feed processing and utilization efficiency. The machines also facilitate formulation of forage or crop residues based diets. Chopped feed will improve feed intake and increase palatability, digestibility and nutrient supply of the improved forages and crop residues based diet to dairy cows hence increase milk production.

1. **The Technology**

Good feeding management practices must be followed to achieve maximum performance from cows. Efficiency dairy cow production can be met when nutrient requirements for dairy cow at various stages of production is known and obtain through combining various feed ingredients to match the needs in a cost efficient way. In addition, the ability to use feeds with various rates of breakdown is enhanced, often enabling even better nutrient utilization. Farmers can also utilize a greater variety of byproduct feeds with a TMR, thereby allowing for possible ration cost savings. The incidence of digestive and metabolic problems often decreases when a TMR is fed, and milk production has been shown to be as much as 5% higher with a TMR compared to conventional rations as a result of these benefits.

Feed inventory and testing forages and feeds for nutritional quality has already been conducted. We plan to update ration formulations based on milk production and prices of local available feed/concentrates. Total mixed rations will be formulated for milking cows using locally available feed. Feed quality/safety will be enhanced through the use of a proprietary blend of organic acids, Mycotoxin binders, and antioxidants within the premix. The Rations will be nutritionally balanced ration at all times, allowing cows to consume as close to their actual energy requirements as possible and maintaining the physical or roughage characteristics, which we now refer to as feed particle size, required for proper rumen function. The Particle size and mixing will be done on farm using the already purchased forage grinder/choppers. The grinders will also be used to mix the TMR’s.

**Objectives**

1. To document the current feeding practices on 16 selected farms (assuming 1 cow per farm) in the study area for green forages and crop residues respectively.
2. To formulate green forage (napier) based TMR’s, crop residue compete rations and determine their quality
3. To conduct one month feeding trials with selected cows on farm
4. Determine farmer perception of the green forage TMR’s and crop residue complete rations
5. Determine the cost and benefits of the TMR’s and crop residue based diets

**Hypothesis**

**We hypothesize that;**

1. Cows fed on improved forage (napier) TMR’s will have increased milk yield compared to those fed on conventional feeding practice.
2. Crop residues based diets will increase milk yield compared to conventional local diets
3. **Methodology**
4. **Study Farms**

The trial will be conducted on farms in 4 Africa RISING project villages (Sabilo, Hallu, Seloto/haysam and Long). These villages are purposefully selected based on the intensity of smallholder intensive dairy cattle keeping, forage production and presence of forage choppers. Farmers to be selected will be farmers practicing intensive dairy production system and have adopted use of improved forages (Napier and Brachiaria) and crop residues. The farmers should have at least one milking cows in lactation (1-5months) and are willing to participate in the trials. It is important to involve farmers because they will eventually be users, trainers and promoters of the technology.

1. **Farmer Selection**

Sixteen (16) dairy cows will be sampled and used to conduct on farm trials for napier and crop residues based diets respectively.

* To initiate the trials, meetings with farmers groups from the respective villages will be organized to create awareness and select volunteer farmers to participate in the trials.
* Target farmers will be required to be those who keep at least one crossbred cow under zero grazing system.
* Show interest to participate in the trials and have planted at least ¼ acres of improved forages (Napier or Bracharia grass) or utilize crop residues for cattle feeding.
* The selected farmers will be trained on the feed processing, feeding, roles and responsibilities, data collection and trial management.

1. **Objective 1. To document the current feeding practices on 20 and 8 selected farms (assuming 1 cow per farm) in the study area for green forages and crop residues respectively.**

A structured questionnaire will be developed and administered to each host farmer to collect profile data of each host farm participating in the study.

**Farm profiling data to be collected include;**

* + Livestock inventory - types of animals
  + Feed inventory – forages, supplements, crop residues costing
  + Feeding and feed processing strategies - zero grazing, semi zero grazing, open grazing etc.
  + Water – source, availability and amounts offered to animals
  + Milk production
  + Land resources – acreage
  + Distance to markets – nearest market
  + Household information
  + Housing – feed troughs

**Criteria for selecting farms and animals**

* Farmers should be able to take daily records
* Must be zero grazing farms with feeding facilities
* Cows must be lactating in the first 5 months
* Farmers must be willing to participate and offer their animals

1. **Objective 2: To formulate green forage based TMR’s, crop residue complete rations and determine their quality.**

The data collected from the farmer profiling survey will be used to understand the type of feed resources available at each host farm. This data on livestock inventory, body composition and milk production will be used to formulate specific host farm rations based on available feed resources. Pearson square method in excel will be used to balance the available ration to make a complete ration. Forage Choppers will be used to chop green forage and crop residues as well as grind the available concentrates. These ingredients will further be mixed by the forage chopper to formulate a ration.

1. **Objective 3: To conduct one month feeding trials with selected cows on farm**

A total of 16 animals will be selected for the napier forages and crop residues trials respectively.

* + - 1. **Experimental Layout**

The experimental layout will comprise two groups of farmers that will be selected through the list of improved forages and crop residues adopters. A total of 16 cows in early lactation will be selected. Early lactation has been chosen because it’s easy to monitor increase in milk production and attribute it to feed. Cows will be subjected to one of treatments 1 and 2 (Figure1). Farmer groups will be introduced to the new technology, the approach of testing and expected benefits. A total of 16 cows/farmers belonging to these farmer groups with cross bred cows and practicing zero grazing systems will be identified through groups. One recognized limitation of this design is that it is not possible to put all treatments on a single farm, as farmers only tend to own 1 cow at a time. The implication of this is that the observed treatment effects may include some ‘farmer differences’ in terms of management of the animals which cannot be separated from the effect of the treatment (statistically labeled: confounding). However, in order to replicate as much as possible how treatments perform under real conditions it was decided that this implication be accepted but recognized when drawing conclusions from the data. Therefore a cross over experimental design will be adopted to take care of differences in breed, management, and health and lactation stage of the animals (figure 1 and two).

Figure 1: Experimental Layout for green forage and crop residue based rations

**Crop residue based diet**

**8 cows**

**Napier based diet**

**8 cows**

Hallu village

4 cows

Long village

4 cows

Haysam village

4 cows

Sabilo village

4 cows

There will be 2 phases in each treatment, phase 1 as control and phase 2 as actual trial. Cows will be randomly assigned to any treatments. After 30 days dairy cows in each of the treatments will be crossed over to the other treatment for 30 days. A period of 14 days will be used to flash the animals from the previous diet.

* + - 1. **Treatments**

1. **Total Mixed Rations**

The design of this trial will comprise of 2 feeding treatments (Conventional feeding practice: ‘control’ and napier based rations: experiment). The feeding will be conducted for 8 weeks. The proposed full combination of treatments is:

|  |  |  |  |
| --- | --- | --- | --- |
| **Treatment** | **Treatment Description1** | **Duration3** | **Number of Cows2** |
| 1 | Control (Conventional feeding) napier fed separately with concentrates. | 8 weeks | 8 |
| 2 | Napier based rations (forages chopped to appropriate size and concentrates ground and mixed in right proportions to make a complete rations). | 8 weeks | 8 |

12One crossbred cow will be selected per farm.

3 All animals will be subjected to both treatments after every 8 weeks.

Sample size: The required sample size was calculated for a 2‐sided t‐test comparison of means. For the milk yield response, 8 cows of each treatment will be required in order to find a difference between napier or crop residues based diet and ‘control’ treatments after 8 weeks as statistically significant. This was calculated at the 5% significance level with 80% power. Variation between animals within a treatment will be calculated using data from previous studies.

1. **Crop Residues Complete Rations**

The design of this trial will comprise of 2 feeding treatments (Farmer practice feeding: ‘control’ and Crop residue based rations: experiment). The crop residues based complete rations will be formulated from on farm available ingredients. The feeding will be conducted for 8 weeks. The proposed full combination of treatments is:

|  |  |  |  |
| --- | --- | --- | --- |
| **Treatment** | **Treatment Description1** | **Duration3** | **Number of Cows2** |
| 1 | Control (Conventional feeding) forages fed separately with concentrates. | 8 weeks | 8 |
| 2 | Crop residue based rations (rations balanced according to the animals nutrients, energy and protein requirement using local ingredients). | 8 weeks | 8 |

1The amount of complete rations to be feed twice per day is yet to be determined

2One crossbred cow will be selected per farm.

3 All animals will be subjected to both treatments after every 8 weeks.

Sample size: The required sample size was calculated for a 2‐sided t‐test comparison of means. For the milk yield response, 4 cows of each treatment will be required in order to find a difference between complete rations and ‘control’ treatments after 8 weeks as statistically significant. This was calculated at the 5% significance level with 80% power. Variation between animals within a treatment will be calculated using data from previous studies.

* + - 1. **The Approach**

The trials will be conducted in partnership with local District Extension staff and farmer groups. We shall organize meetings with each farmer group belonging to the respective village separately in their villages. During these meeting we shall:

1. Discuss different options of conventional cow feeding‐ this will form part of gathering information to understand conventional cow feeding systems in trial areas.

2. Introduce the improved napier technology and discuss potential benefits as well as documenting farmer’s feedback on the new technology

3. Introduce complete ration formulation of crop residues and discuss potential benefits as well as documenting farmers feedback on the new technology

4. Develop plans for a simple trial to test the new technology napier and crop residue complete rations.

a. This will allow farmers to compare their current practice and new, and decide if it worthwhile to adopt the new technologies. In doing this we shall:

1. Ensure farmers agree on what is ‘normal practice’ as this is the basis for comparisons.
2. Make sure that all farmers agree on the kind of data to collect.

4. Ask the groups to select volunteers to conduct these trials on their farm. Since this will be a researcher controlled, farmer managed, trial, volunteer farmers will be tutored about the trial and how to collect data.

5. We shall discuss the implementation of the trial with the volunteer farmers and develop an action plan.

6. We shall make farm visits to volunteer farms. During these visits data on dairy management systems, feeds (types, quantities, quality etc) and feeding regimes, cattle reproduction issues, feed and milk marketing etc will be collected by use of a structured questionnaire to help understand the nutritional status on selected farms over the previous 3 – 6 months.

Cows will be recruited and randomized to their respective treatment as they are selected. Cows will be managed under respective farm conditions. Volunteer farmers will be trained to make the napier as well as crop residue based rations and collect data themselves. If for some reason cows fall ill farmers will be allowed to have them treated but keep records of date, symptoms and type of treatment administered. Village extension staff will make weekly checks on the data collection process in additional to telephone follows ups. A technician will be recruited to monitor the trails on a daily basis.

7. One of the important issues to be considered is full women and youth participation in the study. Thus, in every step when implementing the intervention women and youth will participate and they will be given an opportunity to prepare and contribute their experience towards the assessment and the new advanced technology which will follow after this exercise.

* + - 1. **Monitoring the Trials**

A research technician will monitor the trials daily and discuss the trial with the implementing farmers as well as record the results and interesting points/observations. The technician will also be tasked to insure that the farmers are feeding the right amounts of feed rations and water. At the end of the trial, we shall hold a final meeting to report the results to all group members and interested farmers in the village. This will include the trial results, feedback from the volunteers and an economic analysis to calculate the financial benefit of the new technology. These meeting will be held on the farms of volunteer farmers.

* + - 1. **Roles and responsibility of host farmers will include;**
* Willingness of farmers to provide labour
* Farmers will provide local feed recourses
* Project will provide supplements
* Extension staff will monitor the trials.
  + - 1. **Data collection**

The host farmers will be trained to collect the following data with the help of the technician:

* Daily feed intake (offered and refusals)
* Daily water intake
* Daily milk yield (Morning and evening)
* Weekly live weights during trial
* Time taken to prepare and feed will be recorded over 8 weeks of the trial
* Cow health data (disease symptoms and treatments etc)
* A record of farmer’s observations – calf behavior, feeding habits etc.
* Record costs of feeds, transport and labour used.
* Fortnightly feed diet samples (quality determinations and mycotoxin analysis)
* Quantify time taken to make and feeds rations
  + - 1. **Data Analysis**
* Data will be entered on an online ODK template and later transferred to Stata for analysis
* Descriptive statistics will be generated to get means and standard deviation for the weights, milk yield and feed wastage.
* ttests will be done in Stata to compare differences in milk yield, weight gain, feeding time and feed intake between napier/crop residue based ration
* and conventional feeding.

1. **Objective 4: Determine farmer perception of the forage Rations**

The social science team will support a study on male and female farmers’ preferences of feed rations. Insights into gender dynamics around ration preference, labour and benefit sharing among others will contribute to an assessment of how acceptable the technologies are for different social groups. The already existing tool will be aadapted as discussion guide; inclusion of gender analysis questions related to introduction of improved forage technologies.

The following activities will be followed to carry out the study;

1. Organization of gender-separate focus group discussion in three villages, choice of time and location that considers women’s constraints to participation.
2. Sampling of 6-12 participants per group (purposive sampling considering age and gender) and personal invitation of participants.
3. Choice and training of facilitators (male facilitators for male groups, female facilitators for female groups) and training of note-takers (responsible for thorough documentation).
4. Implementation of focus group discussions.
5. Expanded note writing or transcription of recordings.

The focus group discussion findings will act as a basis to guide formulation of a tool to conduct a survey on farmer perception and preference of the introduced rations. A structured questionnaire will be developed and administered to each host farmer to collect profile data of each host farm participating in the study.

**Data to be collected include;**

* Types of rations adopted
* Reasons for adoption gender disaggregated
* Reasons for not adopting disaggregated
* Ways of improving the rations

**Criteria for selecting respondents**

* Host farmers of ration Trials
* Farmer who are beneficiaries of the Africa RISING training in ration formulation
* Farmers who have adopted the ration technology via trainers of trainers
* Spill over adopters of the technology

1. **Determine the cost and benefits of the napier and Crop residue complete rations**
   1. **Methodology**

The introduced forage rations will be subjected to a cost benefit analysis case study. The cost-benefit will be carried out by taking into account the input costs of the technology and the value of the outputs expected from application of the technology. The variable costs of growing each technology will be equated by calculating the variable costs of production. This involved all incurred costs and shadow costs such as family Labour and gifts. The costs for family labor and gifts that are directly used in producing the rations will be equated to market prices with the help of local extension officers. All the fixed costs will not be included in the estimates because they are insignificant in influencing feed costs and do not affect the optimal combination of the variable inputs. They were also excluded because they are usually used in other farm enterprises and their input is usually insignificant (e.g. hand hoes or panga).

* 1. **Data to be collected**
* Cost of labor
* Cost of inputs (feed, concentrates, vitamins and minerals)
* Cost of transport
* Cost of milk
* Revenue from sale of milk
  1. **Data analysis**

Total cost expended and benefits accrued from implementation of the technology will be estimated. A benefit to cost ratio (BCR) will be computed to arrive at overall decision whether a given technology is economical or not. A given feed technology will be declared economical if the quotient of benefit to cost ratio is greater than or equal to one (BCR≥1 and it is considered uneconomical if the BCR is less than one (BCR<1). The results will help validate the feed rations. ttest will be used to evaluate whether the costs of producing each the forage based ration feed are significantly different from the conventional feed in the areas under study.

1. **From this data we expect to:**

* show benefits of increased milk yield – calculate and analyze milk yield increase
* show farmers how profitable the technology is ‐ calculate and analyze cost benefit calculation
* document cow feeding regimes on trial farms and show opportunities for improvement
* sensitize farmers on technology
* Compare labour input costs – this has been included because it has a very significant influence as to whether farmers will adopt the technology or not.

1. **Expected calf related benefits**

Overall the TMR and crop residue complete rations are expected to improve cow milk yield. The measurable indicators include:

* Increased palatability
* feed is completely consumed without any wastage
* Increased Digestibility and feed conversion ratio.
* Increased milk yield and manure quality
* reduced cattle nutritional diseases
* reduced health problems especially bloat and mycotoxins.

1. **Participants in Implementation and roles**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Objective** | **Delivery** | 1. **Who** | 1. **How** | 1. **Pathways** |
| 1. Determine quantity of feed wasted from traditionally processed methods. | Amount of feed wasted quantified | Ben Lukuyu, Alphonce Haule, Patrick Mudavadi and Ngunga David | On farm experiment | 4 farmers per village will be selected to participate in the trials |
| 1. Conduct an impact assessment of the TMR’s and complete rations | Reduced wastage and increased feed palatability, intake, manure quality and milk yield. | ILRI and IFPRI Scientists | Impact assessment | Survey |
| 1. Determine cost and benefits of the Rations. | Costs and benefits determined | Ben Lukuyu, Bekele Kotu, Haule Alphonce, Patrick Mudavadi and Ngunga David | Seasonal Data collection of costs and benefits | Statistical analysis |
| 1. Participatory assessment of the rations by Male and female farmers’ | Deeper understanding of farmer preference’s based on gender | Ben Lukuyu, Gundula Fisher and David Ngunga | Survey | Statistical analysis |